Master Console System Monitoring & Control Development

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The Master Console internship during the summer of 2013 involved the development of firing room displays and support applications at the John F. Kennedy Space Center (KSC). This position was with the Master Console Product Group (MCPG) on the Launch Control System (LCS) project. This project is responsible for the System Monitoring and Control (SMC) and Record and Retrieval (R&R) of launch operations data. The Master Console is responsible for: loading the correct software into each of the remaining consoles in the firing room, connecting the proper data paths to and from the launch vehicle and all ground support equipment, and initializing the entire firing room system to begin processing. During my internship, I created control scripts using the Application Control Language (ACL) to analyze the health and status of Kennedy Ground Control System (KGCS) programmable logic controllers (PLCs). This application provides a system health and status display I created with summarized data for use by Master Console Operators (MCO) to monitor and verify the integrity of KGCS subsystems.

Nomenclature

ACL	=	Application Control Language
ILOA	=	Integrated Launch Operations Applications
KGCS	=	Kennedy Ground Control System
KSC	=	Kennedy Space Center
LCS	=	Launch Control System
MCO	=	Master Console Operator
MCPG	=	Master Console Product Group
NASA	=	National Aeronautics and Space Administration
NE	=	NASA Engineering
PLC	=	Programmable Logic Controller
R&R	=	Record and Retrieval
SLS	=	Space Launch System
SMC	=	System Monitoring and Control

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I. Introduction

The John F. Kennedy Space Center (KSC) has served as America's spaceport since the late 1960s, hosting all of the federal government's manned spaceflights. As the space program has evolved from Apollo to Shuttle and now to the Space Launch System (SLS), KSC has operated to meet the demands of each program. This internship was within the Control and Data Systems Division (NE-C) which works to provide scalable launch control systems to support operational testing of a wide range of spacecraft, payloads, and launch vehicles. Specifically, the internship project was part of the Master Console Product Group (MCPG), which is responsible for the System Monitoring and Control (SMC) and Record and Retrieval (R&R) of launch operations data.

Within the firing room, there are hundreds of consoles, servers, and network devices used to distribute and display the appropriate information to the correct Firing Room operator. Consoles are the equipment that Firing Room operators use to view data and send commands. Each of these operators make judgments based upon the information they are presented, so the task of ensuring accurate and up-to-date data is extremely important. The Master Console is in place to fulfill this task by performing integrity or health monitoring of all firing room assemblies, including the other consoles. If a failure occurs, the Master Console provides malfunction recovery and performs the necessary reconfiguration to allow the failed unit or spare unit to be brought back into service.

II. Master Console Health & Status Displays

As part of the MCPG, System Monitoring and Control provides end-to-end command and control enabling the LCS Master Console Operator (MCO) to configure, monitor and control LCS hardware and software. The MCO has the responsibility to guarantee that all other Firing Room operators, such as the cryogenics or thrust vector control operators, are receiving current and accurate information on their respective console. This is done through the use of enterprise management software to provide a centralized subsystem and is then expanded with additional functionality via custom software development. To ensure that the data the MCO is viewing is correct, connectivity and validation tests are performed multiple times each second on every process. This health and status information is then presented to the MCO through the management software and additional supplemental displays.

The applications and displays that were created as part of this internship are used to complement the information given in the management software. Integrated Launch Operations Applications (ILOA) displays are created using an extendable framework of editing tools and auxiliary applications. These displays receive measurement and command data through unique identifiers which are updated at a constant interval. The Master Console system health and status display created through this internship is used to monitor and verify the integrity of the servers, gateways, network switches, and firewalls used in the firing room. Each device has a health status which ranges from normal to emergency and is shown using corresponding severity colors. Additionally, each device has a service state which indicates whether the device is configured, initialized, or in one of various other states. One particularly critical component of this display is the SMC heartbeat. The heartbeat is a connectivity and validation test performed at a regular interval. If the heartbeat were to stop, the MCO would not know if the data being used by

console operators is accurate and up-to-date. For this reason, maintaining the heartbeat is a mission-critical requirement because launch will not occur without it.

The Kennedy Ground Control System (KGCS) health and status display provides a summarized view of the communication bridges and programmable logic controllers (PLCs) used to interface with ground support equipment such as the sensors, valves, switches, and other end-item devices located on the launch pad. There are hundreds of modules, each with their own health, so to effectively present this information to the MCO the data must be combined into groups. The cumulative health of these groups is then displayed and if an issue arises the MCO is able to look within the concerned group of devices at a narrower selection. To combine the data, I created control scripts using the Application Control Language (ACL) which are automatically executed whenever one of the devices within its group changes. These groups are then categorized by subsystem, such as environmental control system or ground special power, and presented on the KGCS health and status display for the MCO to verify.

III. Conclusion

The Master Console Product Group (MCPG) serves the vital role of ensuring reliable data for the entire firing room. Within the MCPG, System Monitoring and Control enables the Master Console Operator to monitor and control LCS assemblies. To accomplish this, the MCO has access to management systems and additional information displays. During my internship, I was involved with the development of new health and status displays and control scripts for use by the MCO to verify that the firing room systems and KGCS equipment are in operating condition. As the infrastructure and systems that form NASA's SLS continue to mature, so will the demands of the Master Console. The health and status displays which I have worked on as part of this internship will continue to develop as the future needs become realized.

IV. Internship Experience

The past several months I have had the opportunity to intern at the Kennedy Space Center within the Master Console Product Group of NE-C2. The development of new System Monitoring and Control health and status displays has enabled me to become familiar with the subsystems which form the Launch Control System. Furthermore, working at KSC has introduced me to the kind and brilliant people who give NASA its reputation as an amazing work atmosphere. I am so grateful for the generous support given to me by everyone I have met. This summer I have been able to gain invaluable, real-world experience in addition to being exposed to the exciting future of NASA and the KSC. I am blessed to have had the opportunity to be part of this inspirational program.